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A Research Odyssey

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A research odyssey

How researchers plan to keep astronauts healthy in outer space

One small step may be a giant leap for humankind, but it also may be a way to measure an astronaut's health.

An interdisciplinary Kansas State University group is studying how astronauts' movements on Earth — such as small steps, walking or climbing — can indicate their fitness level in space and prepare them for future missions.

The large group — made of kinesiology, engineering and textiles researchers — is working on two NASA grants totaling about \$2 million for four years. The aim is to provide biomedical support for astronauts who engage in extravehicular activities as part of future missions to the moon, asteroids and Mars.

The work focuses on two areas:

- Kinesiology and electrical engineering researchers are working with a lunar obstacle course and exercise ergometers to measure astronauts' physical capacities before they go to outer space. Mechanical engineers are creating a support system to simulate reduced-gravity environments like on the moon or Mars.
- Electrical and computer engineers are working with kinesiology researchers to develop biomedical sensors appropriate for spacesuit use that can monitor astronauts' health wirelessly while using body heat to power the electronics. Apparel, textiles, and design researchers built a model spacesuit to facilitate this research.

A lunar obstacle course

Space travel is inherently dangerous. Microgravity environments weaken astronauts' muscles, bone strength and cardiovascular systems, and make it difficult to perform tasks, such as climbing ladders, collecting rock samples or even walking.

"The question is, 'What is the minimum level of conditioning that the astronaut needs to maintain so that they will be safe at their destination?'" said Thomas Barstow, professor of kinesiology and one of the project's principal investigators. "We need to know that they're going to be strong enough to perform a variety of tasks."

The kinesiology researchers consulted with NASA and watched Apollo mission footage to design an obstacle course that simulates lunar tasks, such as climbing ladders, traversing a rock wall, turning knobs and lifting heavy objects.

As participants go through the obstacle course, the researchers gather physiological measurements, including muscle activity, heart rate and breathing rate. Electrical engineering researchers, guided by Steve Warren, associate professor of electrical and computer engineering, are working with the kinesiology team to analyze data and relate results to ergometer experiments that assess and predict fatigue in targeted muscle groups.

A group of mechanical engineers, led by Dale Schinstock, associate professor of mechanical and nuclear engineering, is developing a support system to suspend participants like a marionette. The system can adjust to simulate gravity on the moon or Mars while researchers gather physiological data.

"We want a description of each person's muscle strength, muscle endurance and cardiovascular endurance, so that we can predict their performance during the simulated lunar tasks," Barstow said.

The research includes numerous graduate and undergraduate students.

Spacesuits of the future

By working with a model spacesuit, electrical and computer engineers are exploring how wearable medical sensors can keep astronauts healthy on future space missions.

Bill Kuhn, professor of electrical and computer engineering, and Warren are among those leading the engineering portion, which also involves four additional faculty members and more than a dozen students. The engineering team consults with Barstow's kinesiology team to understand the practical application of new engineering designs.

"This is a systems-level project where we bring together integrated circuit design, software design, biomedical sensors, wireless technologies and the biology of people," Kuhn said.

The engineers are developing spacesuit biosensors to measure vital data, such as breathing rate or muscle activity, and are creating a wireless communication network so the sensors can connect with each other or with a space station, with minimal modification needed to the spacesuit.

The engineers are using 3-D electromagnetic field simulators and a spacesuit model. Because a real spacesuit costs \$13 million, researchers in apparel, textiles, and interior design built a replica that uses metalized fabric layers to model real suit construction techniques that protect astronauts from the cold and vacuum of space.

Batteries are too dangerous to place in a spacesuit's oxygen-rich environment, so the team is developing new energy harvesting methods that use the temperature difference between body heat and the spacesuit's cooling garment to power radios and the associated biosensor electronics.

"This project is a good example of how when you do something in space, everything needs to be rethought — human elements and nonhuman elements of the system," Warren said. "We have a lot to learn about human physiology and what happens to a person as they physically change in a reduced-gravity environment."

Other involved engineering faculty members include Don Gruenbacher, associate professor and head of the electrical and computer engineering department; Dwight Day, associate professor of electrical and computer engineering; Balasubramaniam Natarajan, professor of electrical and computer engineering; and Tim Sobering, director of the Electronics Design Laboratory.

— By Jennifer Tidball, Division of Communications and Marketing

Watch participants go through the lunar obstacle course:
bit.ly/NASAcourse

